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Effectiveness of the parking guidance system in Frankfurt am Main

Despite the fact that a large number of parking guidance systems have already been introduced, for a long time very few studies were carried out to produce an in-depth analysis and evaluation of their effects on parking behaviour and the flow of traffic. In the Federal Republic of Germany, it is only in the past three years that a few more extensive studies on the effectiveness of parking guidance systems have been instigated.

The study presented here of the effectiveness of the parking guidance system in Frankfurt am Main contributes to catching up in this area. The study was commissioned by the City of Frankfurt am Main and is undoubtedly the most extensive study of its kind so far. It makes it possible, on the one hand, to identify the effects of the parking guidance system; on the other, it allows detailed information to be gained on the parking situation and parking behaviour in the Frankfurt inner city.

The study was designed in collaboration with K. Axhausen (London) and J. Polak (Oxford) and with the firm of Infratest Sozialforschung GmbH (Munich). It deals with the first stage of the Frankfurt parking guidance system, which came into operation on 26 November 1992. At that point in time, the parking guidance system basically comprised the inner-city multi-story car parks within the old city walls. Within this area, some 8800 public parking spaces are currently available, 6850 of which are within the 12 public multi-storey car parks and 1900 on the street. In addition, there are at the moment some 800 spaces where drivers park illegally.

Since October 1993, the second stage of the parking guidance system has included the area around Frankfurt's central station, with a further 10 multi-storey car parks. The intention is that in the future the Park & Ride facilities on the outskirts of the city should also be integrated into the system. The overall concept behind the system in Frankfurt am Main has been set out in detail by BOLTZE et al. (1993).

Summary
This article reports on the results of a comprehensive prior and follow-up study of the parking guidance system in Frankfurt am Main. The study, commissioned by the city of Frankfurt am Main, made it possible to partly verify and also quantify some effects of such a system which up to now have largely been only assumed. The knowledge gained in this way can also be applied to a certain extent to other cities.

The database for the study consisted of approximately 3500 personal, oral interviews conducted before and after introduction of the parking guidance system as well as extensive counts in three series. Parking behaviour was surveyed on 12 sample days at 16 multi-storey car parks and in 2 selected street areas.

The results of the study show that drivers have a positive opinion of the parking guidance system. It was demonstrated that the system had positive effects on the utilization of multi-storey car parks during periods of heavy demand for parking space as well as, in particular, on the length of tailbacks at the entrances to multi-storey car parks and on the amount of time spent looking for a parking space. Nevertheless, it must be pointed out that the influence of the system on the overall traffic situation is as yet limited. The reason for this is above all that the parking space situation in Frankfurt am Main is only really under serious strain on a few days each year and that the proportion of overall traffic accounted for by traffic in search of somewhere to park is relatively low.

Methodology

The study is based on data collection and interviews on parking behaviour in the Frankfurt inner city carried out both before and after introduction of the first stage of the parking guidance system. The first series of surveys, carried out before introduction of the system (in September 1992), provides the yardstick for comparison, while the two series carried out after introduction (in February and July 1993) show how drivers have accommodated themselves to the new system. It is essential that the effects of the parking guidance system should not be considered in isolation. Parallel with its introduction, other measures have also influenced the traffic situation in Frankfurt (changes in traffic management, reduction in the number of parking places available on the street etc.).

In order to allow for varying demand situations, the surveys making up the three series were carried out on different categories of days. A total of 16 multi-storey car parks were included in the study, 12 of them connected to the parking guidance system. The other 4 multi-storey car parks were included by way of example in order to gain an idea of the effect of the parking guidance system on multi-storey car parks in peripheral areas of the inner city which were not connected to the system. In addition, licence-plate counts were also carried out on the street.

Counting at the multi-storey car parks and at on-street parking spaces covered the number of free spaces, the number of parking manoeuvres, the duration of parking, the origin of the cars being parked as well as the waiting time and length of tailbacks at car park entrances. The interviews (some 3500 personal, oral interviews) were intended to provide infor- ►

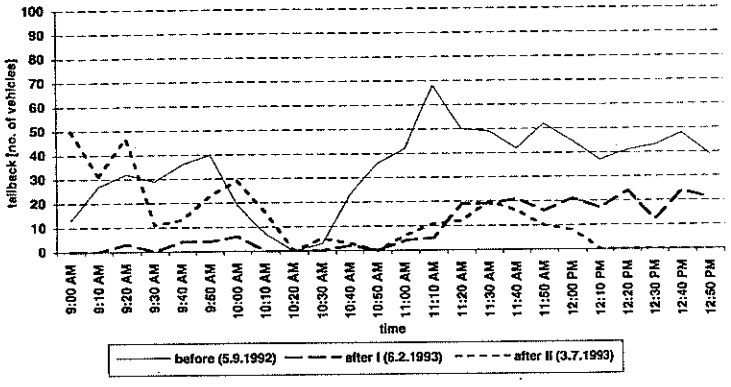

Figure 1: Length of tailbacks at the Hertie car park on "long Saturdays" before and after introduction of the parking guidance system

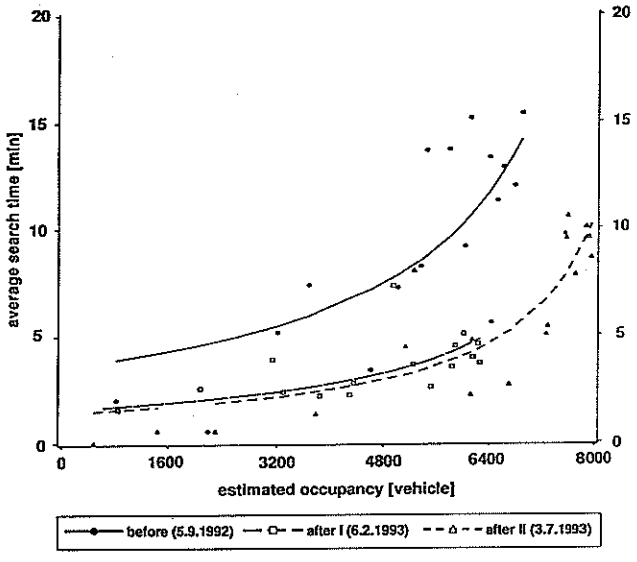

Figure 2: Average amount of time spent looking for a parking space during various occupancy situations in the course of the day ("long Saturdays") before and after introduction of the parking guidance system (AXHAUSEN et al., 1994)

location of the car park	heavy demand	'normal' demand
inner city	○	+
inner city periphery	+	- 1)
beyond inner city	○	○

○ no change
\+ higher occupancy - lower occupancy

1) Effects of the improved sign-posting overlapped the decrease of demand in individual car parks.

Table 1: Influence of the parking guidance system on the occupancy level of multi-storey car parks during various demand situations

tion on parking search behaviour (choice of parking location, searching strategy etc.), to clarify drivers' knowledge, utilization, acceptance and evaluation of the parking guidance system as well as to record a number of characteristics of those interviewed and of the journey they had made. The length of time spent looking for a place to park and the journey time involved were important parameters.

RESULTS

Influence of parking guidance system on traffic behaviour

Occupancy/Utilization of capacity

Usually, the parking guidance system in Frankfurt am Main has an basic influence on traffic flow over a period of about 7 hours a day. This is the period during which individual multi-storey car parks may be full but when the total parking space capacity available has not yet been exhausted. The total parking space capacity of the multi-storey car parks in the Frankfurt inner city is only completely exhausted at various times on so-called "long" Saturdays (Saturdays when the shops are open in the afternoon, i.e. once a month), particularly in the pre-Christmas period.

Since the introduction of the parking guidance system, there has in general been a more even distribution of drivers over the individual multi-storey car parks, especially in the period of heavy demand in the morning. This means that the capacity of the individual multi-storey car parks is not exhausted until somewhat later. Introduction of the parking guidance system has therefore been able to reduce the length of time on Saturdays during which the individual multi-storey car parks are full.
There are considerable differences between the individual multi-storey car parks as regards acceptance and popularity. As expected, it is above all favourable location rather than the actual quality of the multi-storey car parks which is reflected in their level of occupancy and the number of cars entering them. The large percentage of journeys made for shopping purposes (up to 80% of the total) favours particularly those multi-storey car parks which are conveniently located with respect to shopping areas. Multi-storey car parks in a less central location generally achieve considerably lower capacity levels, even if their actual quality is higher.

The effects of the parking guidance system on the utilization of the individual multi-storey car parks are not restricted to periods when their full capacity is used and are very much dependent on the general demand situation for inner-city parking. Whereas during periods of high overall demand it is above all multi-storey car parks in peripheral areas of the inner city which profit, in the "normal" occupancy situation it was primarily those multi-storey car parks which are in any case more popular whose specific level of utilization improved. The system did not appear to influence multi-storey car parks situated further from the inner city. **Table 1** gives a rough presentation of the influence of the parking guidance system on the occupancy of the multi-storey car parks in situations of "normal" and heavy overall demand.

Furthermore, the overall improvement in car park signposting also had a positive effect, particularly on the less well-known multi-storey car parks.

Overall, there was an increase in the number of multi-storey car park customers during the period covered by the study. Sampling was not however able to clarify precisely to what extent the introduction of the parking guidance system had contributed to a concentration of parking space demand on the multi-storey car parks. In this respect the effects of several measures taken to improve parking management in the city overlap one another.

There has been no demonstrable reduction in demand for on-street parking space. As before, this is considerably higher each day than the demand for space in multi-storey car parks. On-street parking spaces, of which there are some 1900, are almost always completely full. The sample surveys which have been carried out show that (because of their higher

level of capacity utilization and shorter parking duration than in the case of multi-storey car parks) they still account for almost 50% of all parking manoeuvres involving public parking spaces in the Frankfurt inner city!

Length of tailbacks and waiting times

Since the introduction of the parking guidance system, there has been a noticeable overall reduction in the length of tailbacks and waiting times at the entrances to the multi-storey car parks involved. This admittedly applies less to weekdays, when drivers in Frankfurt am Main only occasionally need to wait before being able to enter a multi-storey car park. On Saturdays, however, the parking guidance system has led to a clear improvement in the situation. Before the introduction of the parking guidance system, waits of up to 20 minutes were normal at centrally-situated multi-storey car parks. Occasionally, queues of up to 100 cars were observed, with waits of up to 40 minutes. Since the introduction of the system, none of the multi-storey car parks surveyed, with the exception of the Hauptwache car park, has had a waiting time of more than 10 minutes. However, the data collected during the second series of post-introduction sample surveys in June 1993 only allows a conditional comparison to be made; this is because of the lower overall demand on the day when the survey was carried out (cf. **Fig. 1**).

Parking search

The interviews covered both searching strategy and the amount of time required to find a place to park. Questioning drivers as to the latter is not without difficulties from the point of view of methodology, for example because the driver's perception of the amount of time needed may be distorted or because of the different ways in which drivers may distinguish between what they consider to constitute a "search" and a journey directly to a targeted parking destination. On the other hand, the possible alternatives are also not without difficulties. In view of this situation and the resources available, direct questioning of participants seems to be a suitable method of investigation.

Drivers state that on average the amount of time needed to find a parking space on the days surveyed was only between 4 minutes and a maximum of 9 minutes. As a result of the difference in demand, the time required is significantly greater on Saturdays than on weekdays. On average, multi-storey car park users, who spend just under 4 minutes searching, spend significantly less time looking for a space than those parking on the street, who take about 8 minutes. In addition, drivers who park on the street generally have to accept a longer walk to their actual destination.

The relative shortness of the time spent searching already indicates that in this respect the parking guidance system does not offer any very significant potential for improvement, at least not on normal weekdays.

As expected, introduction of the parking guidance system has not led to any significant reduction in the length of time spent finding a parking space on weekdays. On Saturdays, however, the average time spent looking for a parking space was reduced during the period of the study (September 1992 just under 10 minutes; February 1993 just under 7 minutes and July 1993 hardly 5.5 minutes). However, the considerable variations in the volume of traffic had a significant influence in this respect. **Figure 2** shows the average search time during the three series of surveys for varying occupancy situations during the course of the day. It makes clear that there has been a significant overall improvement, even when the demand for parking space is comparable.

Traffic in search of parking space as a proportion of total traffic

Parking experts have so far come up with a wide variety of figures for the proportion of total traffic made up of traffic in search of parking space. Whereas some of those involved suggest proportions of up to 70%, more scientific studies indicate considerably lower figures (eg. Kipke, 1993). This question was investigated primarily in order to be able to evaluate the significance of a reduction in the proportion of traffic searching for a parking space for the overall traffic situation.

	day (24 h)		peak-hour	
	tuesday	'long' shopping saturday	tuesday	'long' shopping saturday
user of car parks	1,5 %	5,9 %	2,3 %	11,6 %
on-street parker	5,8 %	7,2 %	8,3 %	8,8 %
total	7,3 %	13,1 %	10,6 %	20,4 %

Table 2: Traffic in search of a parking space as a proportion of overall traffic in the Frankfurt inner city

In the absence of a generally accepted definition and specification of what actually constitutes time spent looking for somewhere to park, this study was based on the replies of those questioned as to the amount of time they spent searching. Using the total number of parking manoeuvres (on normal weekdays between 8 a.m. and 8 p.m.) and the estimated average speed of cars searching for parking space (25 k.p.h.), it was possible to quantify the volume of traffic looking for somewhere to park. This was compared with the total volume of traffic within the Frankfurt inner city.

In making these rough calculations, the necessary assumptions were made in such a way that they resulted in too high an estimate of the proportion of traffic in search of parking space. Nevertheless, they indicate that on a normal weekday (between 8 a.m. and 8 p.m.) such traffic accounts for hardly any more than a total of 7% and during the peak parking period (10 to 11 a.m.) for only 11% of total motorized traffic in the Frankfurt inner city. For "long" Saturdays, proportions of approximately 13% (8 a.m. to 8 p.m.) and 20% (10 to 11 a.m.) were estimated. The results for the period between 8 a.m. and 8 p.m. are given in **Table 2**. This makes strikingly clear that the greater proportion of traffic in search of somewhere to park consists of on-street parkers. The most obvious strategy to reduce the volume of traffic in search of parking space is consequently to reduce the number of on-street parking spaces available.

Driver acceptance of the parking guidance system

Knowledge and utilization of the parking guidance system

The level of familiarity with the parking guidance system already increased during the first 10 weeks of the system to about 80%, with only a slight further increase during the following few months. A further improvement cannot be expected in the medium term either, given that some 20% of parkers visit Frankfurt am Main less than once a month.

The proportion of those who stated that they had used the parking guidance system at least once during the first 10 weeks of its operation came to 30%. Seven months after introduction of the system, this figure had risen to 40%. That is approximately half of all parkers who were aware of the existence of the system up to that point in time. Overall, the proportion of drivers using the system comes to somewhere between 15 and 20% of total daily parking traffic. When interpreting these figures, one must take into account that the question of whether or not one has actually used the system is a highly subjective one if the system in fact merely leads one to the car park which one would have chosen in any case.

The majority of those interviewed used the information provided by the system merely to check the searching strategy which they had already decided on. However, this not infrequently resulted in their choosing a different destination; some 36% of system users among car park parkers drove to a different car park than the one they had originally decided on. Only 15% of users (i.e. only 3% of all drivers) entrust themselves entirely to the information provided by the system. This low figure is above all to be seen as the expression of widespread reservations against allowing oneself to be directed by a technological system. ►

Evaluation of the parking guidance system by drivers
The drivers interviewed were asked to grade various features of the parking guidance system on a scale from 1 to 6, with 1 being the highest mark. In general their evaluation of the system is positive. Multi-storey car park users gave the system an average mark of 2.1 for their overall evaluation; on-street parkers still gave it an average mark of 2.4.

The drivers' positive evaluation of the system was confirmed when they were questioned as to any improvements they wished to see made. In February 1993 some 25% of those interviewed already stated that changes in the system were unnecessary. Five months later, more than 40% were already entirely satisfied with the form the system took. The most frequent cause for complaint was the system's lack of reliability. However, the effects of the improvements carried out during the second stage of construction were already reflected in the July 1993 evaluation. There were only a few respondents who considered that the system was too expensive or of no use.

Outlook
Investigating the parking guidance system in Frankfurt made it possible to establish various influences on the traffic situation, some of them certainly having general validity. The results can therefore contribute to the decision-making process in traffic management in other cities.

It was possible to partly verify and also quantify some effects of such a system which up to now have largely been only assumed. The effectiveness of the system during periods of high demand for parking space was clearly confirmed. The direct effects of the system are however restricted overall by the fact that the parking space situation in Frankfurt is (still) only really under serious strain on a few days per month. Although drivers in Frankfurt have an extremely positive opinion of the parking guidance system, they only allow themselves to be correspondingly influenced by it to a minor extent. In addition, the proportion of overall traffic accounted for by traffic in search of parking space is, on weekdays, only an average of approximately 7% for the day as a whole and about 11% during the peak hour. This means that it is not yet large enough for the clearly significant potential influence of the parking guidance system to make itself felt in the overall traffic situation.

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Beim Unternehmen Stadt & Kunst arbeiten Künstler, deren Aufgabe es ist, Parkhäuser in hellere, attraktivere Orte mit einer funktionellen Ausstattung umzuwandeln. Jedes Parkhaus erhält eine spezielle Symbol- und Farbenserie; jedes Stockwerk erhält sein eigenes Symbol und seine eigene Farbe. So können die Kunden sich leichter merken, wo sie ihr Auto abgestellt haben, und wird die Atmosphäre des Parkhauses bedeutend verbessert. Untersuchungen haben ergeben, daß die Anzahl der Kunden nach der funktionellen Ausstattung der Parkhäuser innerhalb eines Jahres um 15 bis 20 Prozent gestiegen ist.

La société Stad & Kunst emploie des artistes pour transformer les parkings en des lieux plus gais et plus attrayants grâce à une décoration fonctionnelle. Chaque place de stationnement possède des couleurs et des symboles spécifiques, les divers étages étant caractérisés par leur propre couleur et leur propre symbole. Les usagers des parkings se rappellent plus facilement l'endroit où ils ont parqué leur voiture, alors que l'atmosphère du parking est, elle aussi, grandement améliorée. Une enquête a montré que dans un parking utilisant une décoration fonctionnelle, le nombre de clients a augmenté de 15 à 20 pour cent en une année.

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